VANDENBERG

AIR FORCE BASE

Installation Restoration Program

Cleaning Up CONTAMINATION

FROM INVESTIGATION TO REMEDIATION

The Seven Stages

Cleaning up hazardous wastes associated with past operations is a major focus at Vandenberg Air Force Base (VAFB). In 1980, the Department of Defense (DoD) gave top priority to the management of hazardous materials. In 1981, the DoD ordered its military bases to comply with environmental regulations when implementing remediation of hazardous waste disposal sites. Referencing the Comprehensive Environmental Response, Compensation and Liability Act and the Superfund Amendments and Reauthorization Act, the Air Force developed its own Installation Restoration Program (IRP) which consists of a seven stage approach to cleaning up contamination.

Members of the Community Advisory Board (CAB), a group of private citizens from the surrounding communities as well as elected officials and environmental groups, meet quarterly with the Air Force to discuss cleanup goals and progress as well as review and provide comments on the cleanup documents. This group is the main liaison between the Air Force and their respective communities.

Innovative Technology: An Alternative Approach

This seven stage approach implements technology not available during the 1980's. Phytoremediation and Bioremediation are pilot programs that the base is testing for use as alternatives to the traditional "pump and treat" method.

Phytoremediation is the process where plants are used to remove chemicals from groundwater through uptake and consumption in order to contain or control the migration of contaminants. If the pilot project is successful, VAFB will apply phytoremediation technology to other sites where containment and destruction of contaminants in groundwater is needed.

Poplar trees are planted at a site to control chemicals in groundwater.

One bioremediation program makes use of **oxygen injection wells**. These wells pump oxygen into the contaminated groundwater to enhance the naturally occurring bacteria. The bacteria metabolizes the contaminants quicker with the increased levels of oxygen.

Injecting molasses into groundwater is another innovative approach to cleaning up chemicals in water sources. At one particular site containing the chemical, trichloroethene (TCE), molasses was injected into the groundwater to stimulate naturally occurring bacteria that aided in the degradation of TCE contamination.

The IRP staff is interested and responsive to research projects and new technology. This guarantees the restoration program uses the most cost effective and appropriate method to clean up the environment, protect human health, and ensure the well being of other species.

Stage 1

Preliminary Assessment (PA): Discovery of Potential Hazardous Waste Sites

In 1985 and 1990, the base conducted a preliminary assessment (identification and record searches, and field evaluations) to identify areas that were potential impact sites as a result of operations dating from 1941. If contamination at a site was confirmed, it was selected for further studies under the Site Inspection stage. In cases where contaminants were not detected, the site was recommended for No Further Action (NFA).

Abandoned underground storage tank found during Site Inspection.

Stage 2

Site Inspection (SI): Initial Assessment

Following the PA stage, a review of historical aerial photographs, interviews with numerous base personnel, record searches, site reconnaissance efforts, and inspections of each site will be conducted. During the SI stage, collection and analytical testing of soil, groundwater, and surface water samples will be done at suspected areas. Should contamination be confirmed, the site will be selected for further studies under the Remedial Investigation Stage.

Stage 3

Remedial Investigation (RI): Assessing the Extent of the Problem

Remedial Investigation begins with a study of contaminant source areas and then expands outward to other potentially affected areas. Because human and ecological receptors can be threatened by the movement of contaminants far away from the source area, it is important to closely examine all of the physical characteristics of a site and its surroundings through a well-designed RI program. This information can also aid in the identification of appropriate, and cost effective corrective action.

In order to gather the appropriate information, the project team prepares a sampling plan, collects the samples, and a certified environmental laboratory analyzes the samples for chemicals of potential concern. This comprehensive approach establishes the high quality data needed to support a risk assessment and future corrective action decisions.

Carefully controlled methods are used in sampling and laboratory procedures to improve the quality of data. The development and implementation of a thorough Quality Assurance/Quality Control program is critical to ensure corrective actions are based on high-quality information.

Information gathered during the RI is used to assess the extent of contamination and evaluate exposure pathways at the study site. Invariably, human health and environmental risk assessment becomes an important element of site investigations. Risk assessments provide decision-makers with scientifically defensible information for determining whether a contaminated site poses a significant threat to human health or the environment. Depending on the level of risk identified, stakeholders can decide whether corrective actions will reduce risks to safe levels or determine if the site is recommended for NFA.

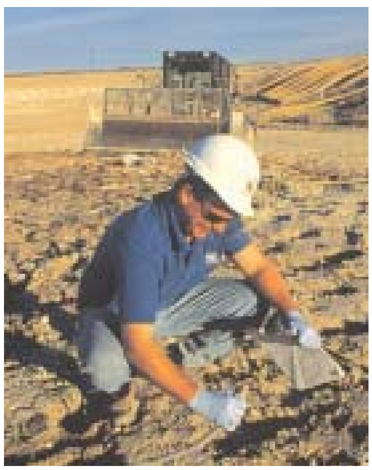
Stage 4

Feasibility Study (FS): The Bridge between Study and Action

Feasibility Studies are performed in order to provide a basis for selecting one or more technologies that can be used to clean up the contamination and minimize risks to human health and environment. The FS identifies and compares all applicable remedial action alternatives at a contaminated site, creating a bridge between the RI study phase and a dynamic plan of actions.

Important factors affecting the FS include the type, concentrations and extent of contamination, and the physical environment. Soil type, depth to groundwater, and airflow patterns are carefully studied at the site, as they are major avenues for human and environmental exposure.

The FS consists of two sequential tasks. First, the broad range of cleanup technologies potentially useful at the site is identified. Second, a detailed analysis of alternatives is conducted, each alternative being evaluated on the basis of technology, effectiveness, permanence, and cost. The limitations of each alternative and regulatory restrictions must be considered before corrective actions can be selected. Where appropriate, contaminated sites at VAFB may be grouped or clustered for cost-effective removal actions based on the results of FS.



Determining soil type is a vital part of the FS stage.

Stage 5

Remedy Selection

The selection of a remedial action is a two-step process as detailed below.

Step 1

Proposed Plan/Draft Remedial Action Plan (RAP): Putting Forth a Cleanup Proposal for Public Review and Comment. Throughout the RI/FS process, the community and stakeholders are kept well informed of site activities through meetings, information bulletins, and by updating the Administrative Record. As the FS stage nears completion, the candidate remedies that were screened and evaluated lead to the identification of a Preferred Alternative. This Preferred Alternative is detailed in the Proposed Plan/Draft RAP, and submitted to the regulatory agencies for initial review. Regulatory review comments are incorporated into a Final Proposed Plan/Draft RAP, which is submitted for public review. A fact sheet describing the goals, technologies involved, the expected performance of the cleanup method, and other information is typically prepared to assist the general public in their assessment of key issues. The fact sheet also

Community Advisory Board Members receive a tour at one of the sites.

provides information on how and where the public can comment on the proposed cleanup method(s). A 30-day review and comment period is provided to the public. Public comments are reviewed before making a decision as to whether the Proposed Plan/Draft RAP may be finalized, or may need to be changed to adequately reflect public concerns and comments.

Step 2

Record of Decision (ROD)/RAP: Documenting Selection of Cleanup Alternative. After the public comment period has ended, a remedial alternative is selected as the remedy that will be documented in the ROD/RAP. The selection of the remedy in the ROD/RAP is based on the analysis presented in the Proposed Plan, giving consideration to agency and public comments. The ROD is the public decision document under CERCLA, and the RAP is the decision document under the California Health & Safety Code. The ROD/RAP includes a Responsiveness Summary, which is a transcript of the public meeting and includes a written summary of significant comments with agency responses. The ROD/RAP must be finalized and signed off by regulatory agencies and stakeholders before the final two stages.

Stage 6

Remedial Design (RD): Detailed Planning for Cleanup

Remedial Design consists of the preparation of a specific set of plans, performance specification, cost estimates, and work schedules to construct and operate the selected remedy at the IRP site. Treatability studies and pilot tests are used to maximize the effectiveness and efficiency of remedial systems before the corrective action is implemented.

Stage 7

Remedial Action (RA): Removal or Reduction of Environmental Risks

The final stage to cleaning up contamination is Remedial Action. The RA stage can be divided into two groups of remediation technologies: *in situ* and *ex situ*. A combination of both groups of techniques may be used.

In situ remediation is a corrective action that treats contaminated soil or groundwater without excavating the soil or extracting the groundwa-

Oxygen Wells Prove to be a Successful Cleanup Technology

Assessing the Problem

Site 60, a former fueling station for GSA vehicles, was identified as having leaks from associated piping and pump islands during a site assessment. A total of four 10,000-gallon underground storage tanks (USTs) that stored leaded and unleaded gasoline and diesel fuel were located on this site.

Due to fuel system leaks, the USTs were removed in 1995 along with fuel-impacted soil. However, a remaining source area of contamination from the leaks was associated with dissolved methyl-tertiary-butyl-ether (MTBE) found in the groundwater.

MTBE is a fuel additive that is used to reduce air emissions (e.g., smog), and it is very soluble in water. At Site 60, the shallow groundwater (6 to 8 feet) rises during the wet season mobilizing MTBE remaining in the soil.

Solving the Problem Through Innovative Technology

The soluble MTBE tends to migrate faster in groundwater than any other contaminants. VAFB and the California Regional Water Quality Control Board were concerned that MTBE would migrate to the Santa Ynez River and the Pacific Ocean. The base partnered with the University of California at Davis and the University of Waterloo, Canada to implement an innovative approach to remove the contaminants at this site.

How?

A Permeable Reactive Barrier (PRB) and a Oxygen Release Compound (ORC) system was installed at the site. These systems add oxygen into the groundwater to enhance the natural biodegradation of MTBE by indigenous bacteria. The system performance is then monitored via up gradient and down gradient monitoring wells. Reports show that since installation of the PRB, levels of contamination have declined steadily each month.

Oxygen coils being monitored as part of the Oxygen Release Compound System.

ter to the surface for treatment. Some examples of in situ remedial actions include:

Excavation of underground storage tank.

Soil vapor extraction — treats soil in place by extracting contaminated vapors. Eventually most volatile contaminants move from the soil particles to the pore spaces between them. These vapors are then pumped to the surface until all contaminants are removed.

Air sparging — strips volatile contaminants from groundwater by bubbling air through the contaminated water using wells.

In situ bioremediation — supplies subsurface microorganisms (bacteria) with oxygen or nutrients to help populations grow and thereby increase sale of natural contaminant decay.

Bioventing — stimulates organisms with oxygen by slowly applying air to wells. With a vented environment established in the subsurface, microorganism populations rapidly expand and metabolize (consume) contaminants.

Ex situ remediation treats contaminated soil or groundwater in a more controlled, environment. Soil vapor extraction, bioremediation, and bioventing can be applied to excavated soils. Some additional examples of *ex situ* remedial actions include:

Soil washing — washes contaminated soil using a water and surfactant solution. Afterward, the solution is treated or recycled.

Incineration — burns the contaminated soil in a furnace or rotary kiln to strip and/or destroy contaminants. Resulting air emissions are carefully controlled.

Air stripping — pumps groundwater into aboveground chambers. Air is then forced through the chambers to strip the contaminants from the groundwater. The vapors are then treated.

Carbon absorption — passes contaminated vapor or groundwater through activated carbon to remove contamination. The carbon is recycled or disposed of in an authorized facility.

Chemical fixation — stabilizes metallic contaminants through the addition of chemicals that bond to them and reduce their toxicity.

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